Calibration of Micromachined Force Sensors by Gravitational Force on Precision Microspheres

STEVEN J. KOCH, GAYLE E. THAYER, ALEX D. CORWIN, MAARTEN P. DE BOER, Sandia National Laboratories — To complement the existing tools for applying and measuring piconewton-level forces on biomolecules (e.g. optical tweezers, magnetic tweezers, AFM), we are developing a compliant micromachined spring for simple and direct measurements in an aqueous environment. Accurate calibration of the spring constant is crucial and we will present a gravitational method that uses NIST-traceable size standard microspheres. The method is applicable to calibration of other soft cantilevers of both in-plane and out-of-plane varieties. We affixed two microspheres to the force sensor and measured a deflection per bead of 196 nm ± 6%. Using a weight of 150 pN ± 4.8% per microsphere, we obtained a spring constant of 0.76 pN / nm ± 8%. The method proved simpler and more reliable when compared to two other methods: high resolution SEM and thermal equipartition. The versatility of surface micromachining should enable use of the spring in new platforms for biophysical force measurement, for example on-chip load cells for dynamic DNA stretching.